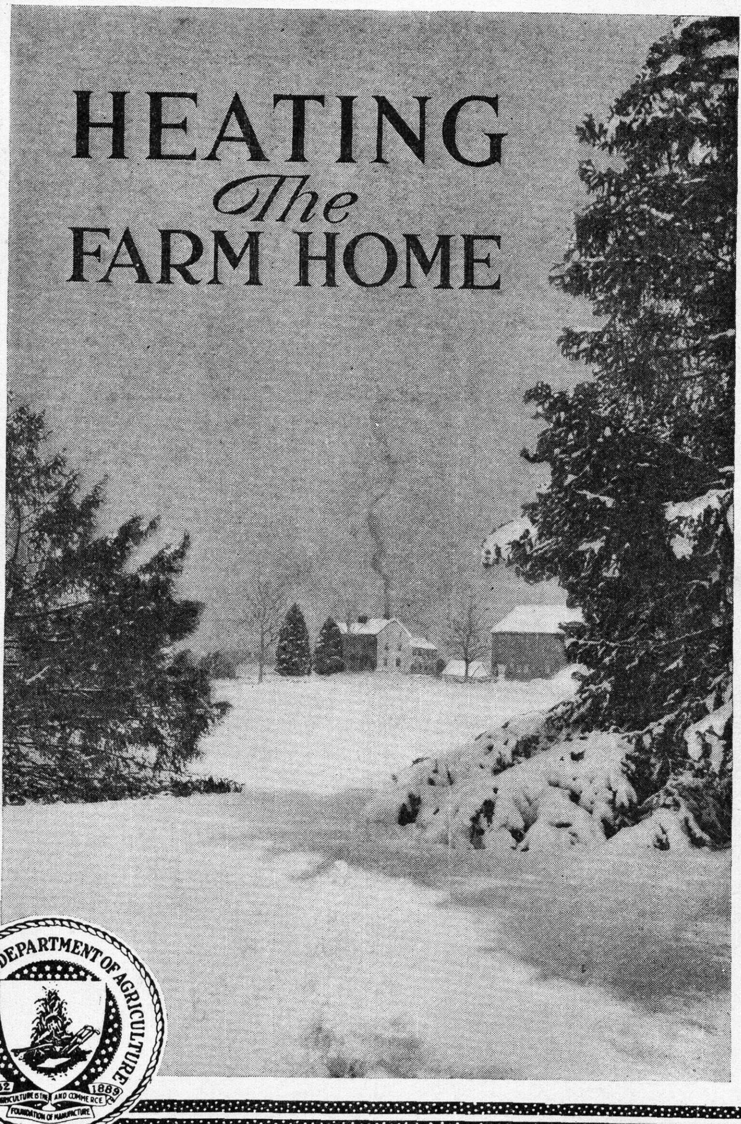
U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1698

HEATING *The* FARM HOME



A WELL-HEATED HOUSE is essential to comfort of farm life in winter. In cold weather comfortable temperatures throughout the house are best assured by a properly designed central heating plant, which may be a pipeless or a piped warm-air furnace, a hot-water system, or a steam or vapor system.

Satisfactory results in home heating require that the heating plant have sufficient capacity, and be of a type adapted to the house and properly installed.

Comfort depends not only upon a good heating plant, but also upon proper construction of the house to prevent excessive air leakage around doors and windows and the escape of heat through walls and roof.

In this bulletin the requirements that should be met and the characteristics of different types of heating systems are discussed, and advice is given on selecting heating plants for farm homes and on ways of conserving heat.

This bulletin supersedes Farmers' Bulletins 1174, One-Register Furnaces, and 1194, Operating a Home Heating Plant.

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HEATING THE FARM HOME

By Arthur H. Senner, *Associate Mechanical Engineer, Division of Structures, Bureau of Agricultural Engineering*

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THE CHIEF POINTS to be considered in selecting a heating plant for the farm home are: First cost, operating costs, convenience, and durability.

The cost of heating a house depends principally upon: (1) The average outside temperature and the exposure of the house to winds; (2) the degree of weather tightness of the house; (3) the average temperature maintained inside the house; (4) the efficiency with which the fuel is burned and the heat transmitted to the several rooms (this depends upon the personal element as well as design of equipment); and (5) the unit cost of the fuel.

These factors have practically the same effect with all types of systems that are properly designed and installed, and operating costs of different types of systems are not very different, if the plants are handled with equal skill. Correct size and installation of a plant are much more important than its type. With stoves, for example, expenditures for fuel commonly are less than with furnaces because the former do not heat the same amount of space as the latter, or do not heat it to the same degree.

FACTORS AFFECTING HEALTH AND COMFORT

Most well-informed physicians and heating engineers are of the opinion that temperature, humidity, and motion are the most important conditions in the air we breathe. The temperature as indicated by a thermometer does not always give a true indication of the feeling of heat or cold. Dry air at ordinary room temperature may chill the body because it increases the rate of evaporation from the skin.

To restore the heated air of the house to approximately the normal moist condition of out-door air at comfortable temperatures may require the evaporation of one-half to three-fourths gallon of water per hour for even a comparatively small house. To vaporize this quantity of water and mix it with the air of the house would require special equipment, and with so much moisture in the air a great deal of dampness or frost would accumulate on windows in cold weather unless storm windows were used. Usually the humidity in a heated house is considerably below that out of doors.

REQUIREMENTS OF A HEATING PLANT

The heating system should be capable of maintaining comfortable temperatures, should be easily controlled, and should require a minimum of attention. If the entire house is to be heated, these requirements are best met by a plant of the central type; that is, a single boiler or furnace connected with the various rooms by ducts or piping.

The heater should be able to use, economically, a reasonably wide variety of fuels, depending on those available in the vicinity. Most of the furnaces or boilers used in modern heating systems operate most satisfactorily with hard coal and coke. Soft coal produces more smoke and flues and heating surfaces require more frequent cleaning if it is used. However, on account of its lower cost and wider distribution, soft coal is used more generally than anthracite. The smoke is of course less objectionable in the country than in thickly populated areas. Oil and gas can also be burned in heating plants equipped with suitable burners but their efficiency is not always equal to that of solid fuels.[1]

The heating system should be rugged and free from mechanism or accessories that require frequent adjustment or replacement. Pipes, ducts, radiators, and boiler or furnace must be properly proportioned and installed.[2]

PROPER SIZE OF HEATER

The heating system must be so proportioned and installed as to heat the house satisfactorily when the outside weather conditions are most severe. Furthermore, it should have some reserve capacity in order to raise the house temperature fairly rapidly.

Table 1 gives the grate area of a boiler, furnace, stove, or convection-type heater required to maintain an inside temperature of 70° F. under the various outside temperatures indicated. This table must be followed with discretion; a poorly built house will obviously require a heating unit of larger grate area than that indicated.

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[1] See Department Circular 405, The Domestic Oil Burner.

[2] Reputable dealers, including the larger mail-order houses, usually design and guarantee proper installation.

TABLE 1.—*Square feet of grate area required to maintain an inside temperature of 70° F. in houses of average construction and under various outside temperatures*

Volume of house excluding cellar (cubic feet)	Square feet of grate area required when the lowest ordinary outside temperature is—				
	+20° F.	+10° F.	0° F.	−10° F.	−20° F.
2, 000	1	1	1¼	1½	1¾
4, 000	1¼	1½	1¾	2	2¼
6, 000	1½	1¾	2	2¼	2¾
8, 000	1¾	2	2½	2¾	3
10, 000	2	2½	2¾	3	3½
15, 000	2½	3	3½	4	4½
20, 000	3	3¾	4½	5	5½
25, 000	3¾	4½	5¼	6	6¾

A room 10 feet wide, 12 feet long, and 8 feet high contains approximately 1,000 cubic feet.

Round grates have areas approximately as shown in Table 2.

TABLE 2.—*Areas of round grates*

Diameter of grate (inches)	14	16	18	20	22	24	26	28
Area of grate (square feet)	1. 1	1. 4	1. 8	2. 1	2. 6	3. 1	3. 7	4. 3

The area of a rectangular grate, in square feet, is found by multiplying the width of the grate in inches by its length in inches and dividing by 144.

THE CHIMNEY FLUE

The construction of the chimney flue should minimize the fire hazard, and its dimensions should assure an adequate air supply or draft. Details of construction are given in other bulletins of this department.[3] Dimensions of the flue depend upon the size and type of the heating plant to be installed and the kind of fuel to be burned. These facts should be determined before construction of the flue is begun. If the chimney is inadequate the only method of improving it, short of reconstructing it, is to increase its height. This is not always effective and often is impracticable.

Certain general rules for constructing flues can be stated. A chimney flue should have a fire-clay lining and should be as nearly straight from the bottom to the top as possible. The flue should have no openings except that for the smoke pipe from the main heater and a clean-out door. The cross-sectional area of the flue must not be reduced at any point. The clean-out door should make a tight joint with its frame when closed.

Table 3 gives the sizes of chimneys ordinarily provided for boilers, furnaces, stoves, or convection heaters burning soft coal. These sizes have proved satisfactory for average flat-grate furnaces under normal conditions. Manufacturers of heating equipment usually specify certain requirements in chimney construction and will not guarantee the performance of their heaters unless these requirements are met.

[3] Farmers' Bulletins 1590, Fire-Protective Construction on the Farm, and 1649, Construction of Chimneys and Fireplaces, contain information on chimney construction.

Therefore, these recommendations should be followed when they differ materially from the chimney dimensions given in this bulletin.

TABLE 3.—*Sizes of chimney flue linings and heights of chimneys recommended for flat-grate furnaces burning soft coal*[1]

Grate area	Outside size of chimney flue lining		Height of chimney flue above grate	Grate area	Outside size of chimney flue lining		Height of chimney flue above grate
	Round (diameter)	Rectangular			Round (diameter)	Rectangular	
Square feet	*Inches*	*Inches*	*Feet*	*Square feet*	*Inches*	*Inches*	*Feet*
1	9½	8½ x 8½	22	6	17¼	18 x 18	30
2	11¾	8½ x 13	24	7	20½	20 x 20	32
3	13	13 x 13	26	8	20½	20 x 20	35
4	13	13 x 13	30	9	20½	20 x 20	35
5	13	13 x 13	32	10	20½	20 x 20	40

[1] If anthracite coal is to be burned the area of the chimney may be reduced by about 25 per cent.

TYPES OF HEATING SYSTEMS

Farmhouses may be heated by any one of several devices, including fireplaces, stoves, circulator heaters, warm-air, hot-water, and steam systems. The pipeless furnace (so called), the piped warm-air, steam, and vapor systems, as ordinarily used in domestic heating, require cellars. Fireplaces, stoves, circulator heaters, and hot-water heating systems may be used without cellars, though a cellar is desirable for a hot-water system because it makes possible greater cleanliness and better appearance and because such a system generally functions better when the boiler is located below the level of the lowest radiator.

To provide a cellar [4] or pit for the boiler or furnace only a portion of the ground under the house need be excavated. The supply lines or air ducts can be installed in the space between the floor of the building and the ground. An excavation 12 by 15 feet is large enough for the boiler or furnace, coal storage, and stairs. The heater and a small supply of coal can be put into a pit about 10 feet square. It is necessary, of course, to extend the chimney below the floor and to provide an opening for the smoke pipe.

FIREPLACES AND STOVES

The chief advantages of a fireplace are its simplicity of operation, its cheerful effect, and the dignity and homelike character which it adds to a room. Its chief disadvantage is that a large part of the heat from it passes up the chimney and is lost. A fire in the fireplace provides heat quickly and almost any kind of combustible material may be used for fuel. Its warmth is radiant heat that warms objects close to the fire, but not the entire room. A properly constructed arch increases the amount of heat thrown off.[5] Fireplaces are frequently the only sources of heat for single rooms or small houses in mild climates, but in the north their usefulness is

[4] Farmers' Bulletin 1572, Making Cellars Dry, contains valuable information on constructing cellars.

[5] The construction of fireplaces and chimneys is described in Farmers' Bulletin 1649.

limited chiefly to taking the chill off a room when the main heating plant is not in operation.

Stoves utilize fuel more efficiently than fireplaces, since they give off heat on all sides and there is considerable circulation of air warmed by contact with the stove. The loss of heat up the chimney is much less than from a fireplace since the draft is controlled much better. In cold climates a stove is needed for each two or three connecting rooms, or for each room if the doors are kept closed. If the entire house is to be heated by stoves, chimneys must be so located that proper flue connections can be made. In mild climates a single stove may provide sufficient heat for the entire house. The chief advantages of heating by stoves are their low cost, ease of installation, quick heat (especially if wood is burned), and adaptability to a house having no cellar. Disadvantages of stoves are the uneven distribution of heat, the frequent attention usually required, and the necessity of carrying fuel into and ashes out of the living quarters. Furthermore, when a stove is in use it must be set at a safe distance from walls and furniture, and therefore occupies a large space in the room. Stoves seldom harmonize with the other furnishings, and are a frequent cause of accidents to small children.

The cheapest heating stoves are made of sheet iron and have no grates. They use only wood, which they burn efficiently. Such stoves are generally short-lived and are not convenient for heating water. Cast-iron stoves with grates burn either wood or coal and are durable. Oil burners are now available for kitchen ranges, heating stoves, and the circulators or parlor heaters. They use kerosene or the lighter distillate oil fuels. Circulator heaters described on page 6 are now preferred to the more elaborate types of stoves. Ordinary ranges, cookstoves, and laundry stoves will usually warm the rooms in which they are placed. When provided with water backs or coils, they are useful for heating a piped supply of water for household use. Laundry stoves can also be used for a limited amount of cooking.

Equipment manufactured by a reliable concern should be selected in order to be assured of good quality of material and workmanship. A heating stove should be placed on a fireproof mat or base at least 18 inches from any unprotected plaster or woodwork. Smoke pipes should never be run through a partition unless special care is taken to protect the wood from heat.[6]

WARM-AIR SYSTEM

The advantages of the warm-air system are: (1) Its cost of installation is comparatively low; (2) the air motion it produces is desirable for comfort; (3) some moisture can readily be added to the air by means of water pans inside the outer shell of the furnace; (4) ordinarily the temperature is easily regulated, and can be quickly lowered or raised; (5) the system does not require accessories involving expense for upkeep; and (6) it will not be damaged by freezing if the fire is out during cold weather. On the other hand most warm-air systems do not work properly if the room doors are closed, and odors are carried from room to room by circulation of the air.

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[6] See Farmers' Bulletin 1590, Fire Protective Construction on the Farm.

It is sometimes said that a warm-air heating system allows more chance than do other systems for coal-gas or oil fumes to leak into the house because of bad joints in the furnace. Gas-tight steel furnaces which even the intense heat of the oil burner does not cause to leak can now be obtained. Joints in furnaces of other types require periodical inspection and repair. It is best to have an experienced sheet-metal worker install a piped warm-air system.

Warm-air furnaces successfully burn various grades of anthracite, bituminous coal, coke, or chunks of wood. Oil burners are about as effective with these furnaces as with other types.

The simplest form of the warm-air system is the parlor furnace or circulator heater. (Fig. 1.) The advantages of such heaters as compared with stoves are that they give stronger air circulation and better distribution of heat, have a better appearance, and offer less risk since the outer surface is comparatively cool.

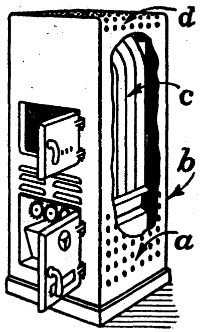

FIGURE 1.—Parlor furnace or circulator heater: *a*, Base grille through which air is drawn to be heated; *b*, casing; *c*, heating surface; *d*, top grille through which warm air rises into room

Such a unit may be placed in a convenient location on the floor to be heated and in a location where good air circulation can be obtained. The cold air is drawn into the grille work shown at *a* and passes up between the casing *b* and the heating surface *c*, the warm air emerging from the grille work *d* in the top of the casing. From this point, the air rises and circulates through the house, returning after cooling to be reheated. Such heating units are generally made to heat from two to eight rooms. They are especially successful in mild climates.

The pipeless (1-register) furnace is similar to the circulator heater. It is essentially a stove inclosed by two metal jackets, one outside the other. As the hot air leaves the central part of the register or heat outlet of the furnace, it rises and diffuses through the several rooms as shown by the arrows in Figure 2. An additional register placed in the first-floor ceiling may assist in heating a second-floor hall or room directly above. Under some conditions, however, the ceiling register may act as a cold-air return rather than as a warm-air passage. The principal limitations of the pipeless furnace are: It is difficult to obtain even distribution of heat in rooms which do not communicate directly with the room or hall in which the register is located; and closing the door shuts off the heat supply from a room, unless a transom or grille is provided.

A pipeless furnace will not provide the most uniform temperature conditions. On the other hand, it is the cheapest type of central heating system of which the heater can be placed in the cellar, thus avoiding considerable dirt and smudge in the living rooms. Manufacturers furnish instructions which enable a handy man to erect such a unit with little difficulty. The services of a sheet-metal worker or plumber are not necessary, but trained workmen can make the most satisfactory installations.

The piped warm-air furnace shown in Figure 3 is similar to the pipeless furnace, but distributes heated air to the various parts of

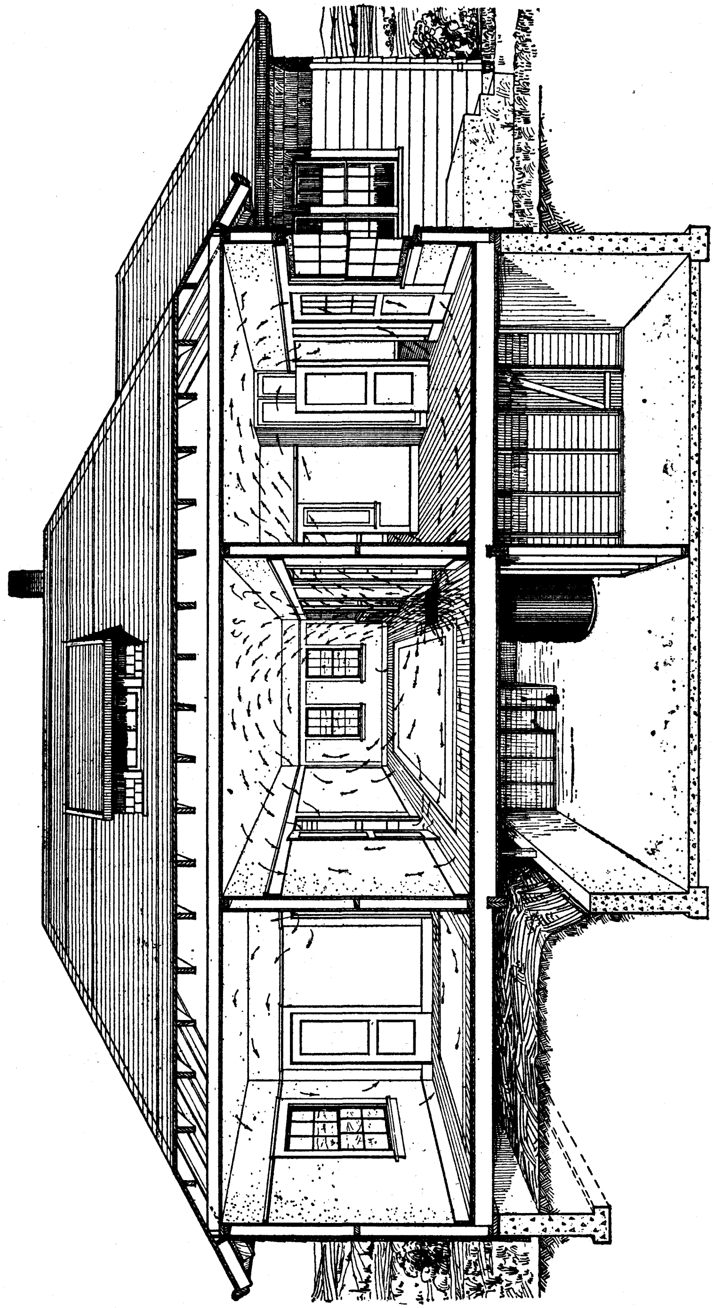

FIGURE 2.—Small house heated by pipeless furnace

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the building through sheet-metal pipes. In general, the horizontal length of a duct should not exceed 15 or 20 feet. Usually the cold air returns from the various rooms through open doors, halls, or stairway, to a common cold-air return leading from the lower floor to the furnace. Separate return ducts may be installed for rooms usually kept closed.

Sometimes part of the air supply is taken from outside the building through a dampered pipe. In no case should it be taken from the cellar, since to do so would circulate cellar dust through the house.

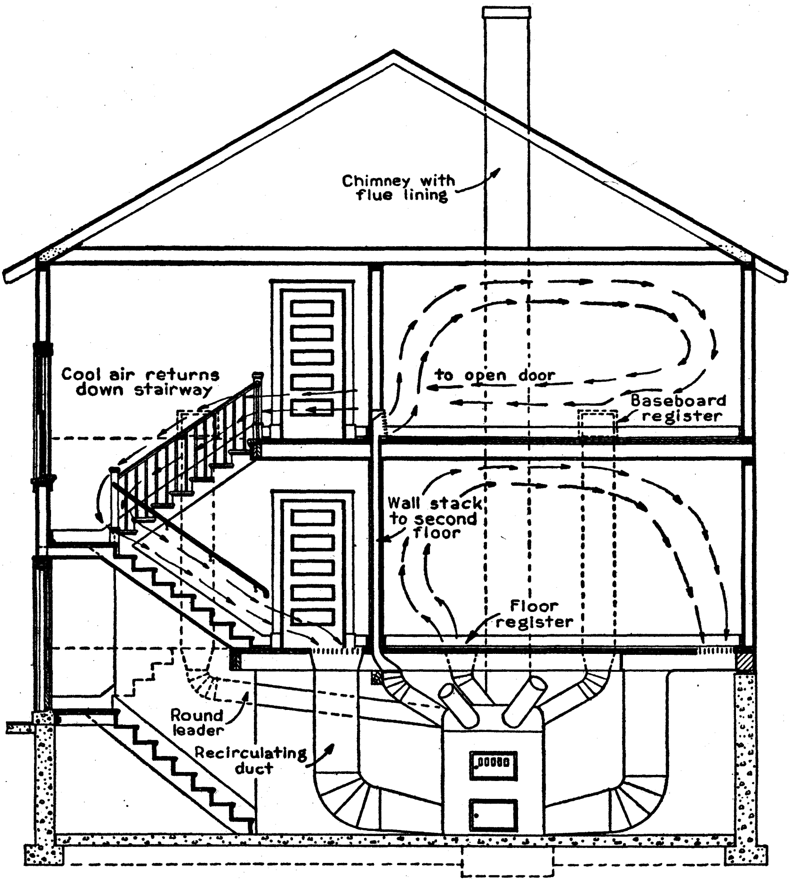

FIGURE 3.—Piped warm-air system

The most economical method is to recirculate the air within the house, as first described, and to admit air for ventilation by opening windows. In many houses leakage admits sufficient air for ventilation.

HOT-WATER SYSTEM

The hot-water heating system uses hot water to convey heat from the furnace to radiators in the rooms. Generally the boiler is placed in the cellar, and the radiators connected to it by pipes. Since hot

water is lighter than cold, the water heated in the boiler flows to the radiators and in giving off its heat there cools and then returns by gravity to the boiler. The radiators are nearly always placed against outside walls, and often under windows.

Advantages of the hot-water heating system are: It is rugged and free from accessories that need adjustment; it can be controlled to meet a wide range of outside temperatures; the boiler generally is equipped with automatic draft-operating devices; a large amount of heat is stored in the circulating water and thus prevents sudden fluctuation of room temperatures; and the system can be installed satisfactorily in a house having no cellar.

Disadvantages of the hot-water system are: It will not meet quick changes in temperature; moisture can not readily be added to the air; and if the fire goes out during very cold weather, the water must be drained from the system to prevent serious damage from freezing.

It is best to have an experienced heating contractor install a hot-water system.

A hot-water installation in a building without a cellar is shown in Figure 4. The piping is shown exposed, although if the system is installed when the house is built the main lines, at least, may be concealed. The boiler generally provides enough heat in the room where it is located. The supply lines are run overhead, pitching down gradually from a high point over the boiler to the vertical feeders to the radiators. The lines carrying the water back to the boiler are shown at the floor line in Figure 4. In small systems of the type shown, control valves at the radiators are frequently omitted.

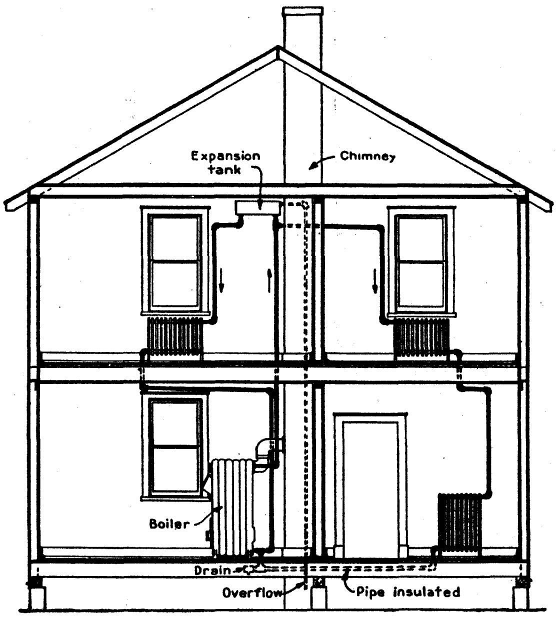

FIGURE 4.—Hot-water system in house without cellar

In the ordinary "open" hot-water system, as illustrated in Figures 4 and 5, an expansion tank with overflow allows for expansion of the water as it is heated. In practice the water is seldom heated above 180° F. The expansion tank must be placed where it will not freeze.

In the newer "closed" system, the water is held under pressure of 15 to 30 pounds per square inch, and may therefore be heated to much higher temperatures than in the open system, making circulation more positive. The closed system is gaining in popularity. Smaller pipes and radiators may be used with it than with the open

system. The capacity of an open system having insufficient radiation can sometimes be increased by converting it to the closed type.

No open tank is used in the closed system. If the pressure becomes excessive, a relief valve opens, permitting a little water to discharge to the floor drain. When the pressure in the heating system drops below the desired level, a reducing valve admits water from the house supply. A reliable relief valve is necessary in the closed

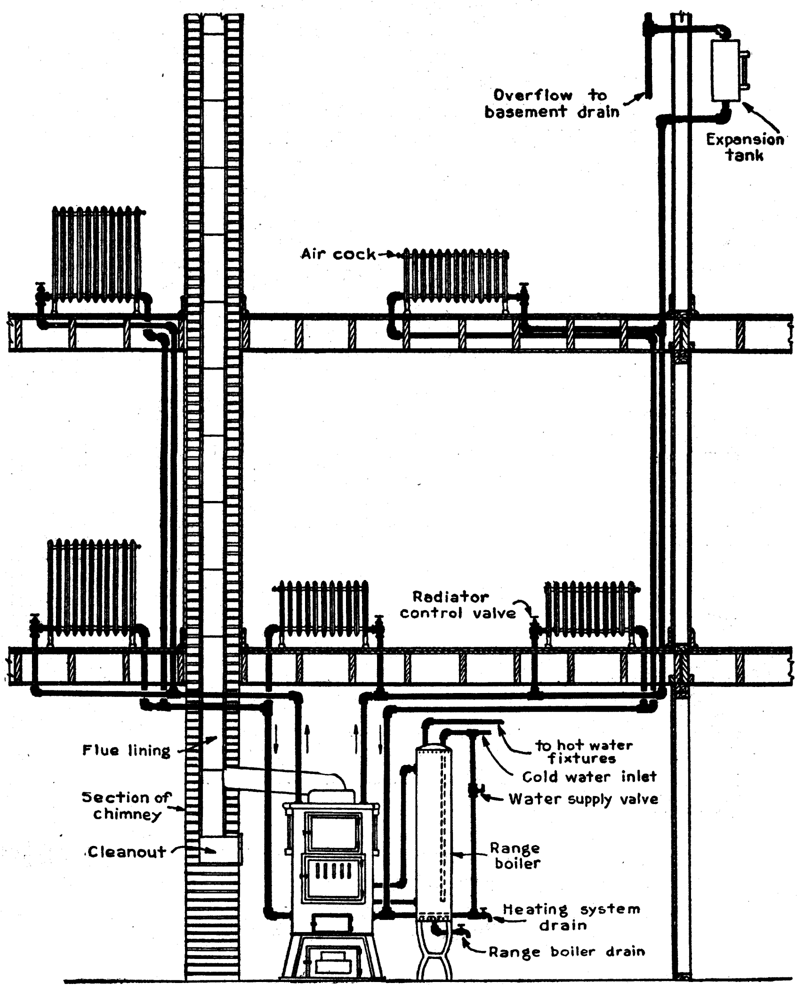

FIGURE 5.—Hot-water heating system with boiler in cellar

system but the amount of heat lost through occasional venting of water is negligible if the system has been properly installed and adjusted. There should be no material difference in fuel consumption between the open and closed systems, other things being equal.

STEAM SYSTEM

A steam heating system consists of a boiler and a system of pipes connecting it with the radiators, which are usually placed next to

the outside walls. Steam from the boiler passes into the pipes and through them to the various radiators where it gives up its heat and condenses into water which returns to the boiler by gravity. There are several modifications of the steam heating system. Often the amount of piping and radiation required is considerably less than for a hot-water system, on account of the higher temperature of the steam. As with the hot-water system, it is best to have an experienced heating contractor install a steam heating plant.

Of the steam systems the 1-pipe type is the simplest and perhaps the most satisfactory for the average farm home. The steam is conducted to the radiators and the condensed water returned to the boilers through the same pipe. In the 2-pipe system the condensed water returns to the boiler through separate pipes.

All radiators must be fitted with valves to allow the escape of air as steam fills the system. These may operate merely to allow escape of air, or may also act to maintain a partial vacuum in the system when steam pressure falls, thus increasing the time during which the radiators are warm.

The advantages of the steam system are: Its cost is low as compared with that of other types of radiator heating; smaller radiators are required than for the other systems; the room temperature can be raised rapidly; and the system is practically free from accessories requiring attention. The principal disadvantage of the ordinary steam heating system is that it contains very little stored heat and therefore requires more attention to the fire than do any of the other systems.

The vapor system is a modification of the 2-pipe steam system. The air is vented and condensed water returned to the boiler through a return trap installed on the return main near the boiler. The vapor system permits operation at lower steam pressures and requires less attention than does the ordinary steam system. It permits closer regulation of the flow of heat to individual radiators.

Since the condensed water from the radiators returns to the boiler by gravity, the boiler for an ordinary simple steam system or vapor system must be in the cellar.

TYPES OF BOILERS

Boilers for steam and for hot-water heating systems are made in several styles, with no great difference in their efficiency. Perhaps the simplest type is that shown in Figure 4. It is suitable only for small hot-water jobs where there is no cellar. The heater is compact and the doors fit well enough to keep most of the dirt and soot out of the rooms.

Boilers for larger houses may be either round or rectangular. Both types are, as a rule, built in sections. Sectional boilers burn most of the grades of solid fuel satisfactorily, and may be equipped to burn oil. The differences for hot water or steam are very slight. Such boilers are usually equipped with automatic temperature or pressure controls. Some manufacturers provide attractive enameled sheet-metal coverings (fig. 6) with insulation between the coverings and the boiler proper. Otherwise some form of plastic insulation is generally applied after installation. The insulated sheet-metal cov-

ering costs practically the same as the plastic insulation and is far more satisfactory. Plastic coverings generally flake or chip off.

The magazine-feed type of cast-iron boiler is designed to burn small-size anthracite, coke, or graded noncoking bituminous coal. It can not be used with coals which form a crust. The fuel is put into the magazine above a sloping grate and forms an inclined fire bed which always maintains practically the same thickness, since, as fast as the fuel burns, it shrinks and settles on the grate, thus allowing an additional supply to flow down by gravity from the magazine. The magazine-feed boiler is well adapted for use with automatic room-temperature-control devices because of its self-feeding principle and the large storage of fuel. For a given capacity the price of the magazine-feed boiler may be somewhat higher than that of the ordinary cast-iron flat-grate boiler shown in Figure 6.

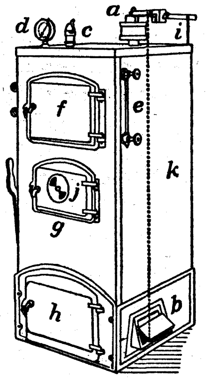

FIGURE 6.—Sectional boiler with sheet-metal jacket: *a*, Steam - pressure regulator; *b*, primary draft damper; *c*, safety valve; *d*, steam-pressure gauge; *e*, water glass; *f*, flue clean-out door; *g*, fire door; *h*, ash-pit door; *i*, rod to check and choke damper; *j*, secondary air damper; *k*, enameled - steel insulated jacket

INSTALLATION COSTS OF VARIOUS SYSTEMS

An estimate of the cost of any particular installation can be had by submitting complete specifications and plans to one or more heating contractors or supply houses. Relative costs of the several types, expressed in percentage of the cost of 1-pipe steam system, are about as follows:

	Per Cent
2-pipe vapor system	150
2-pipe hot-water system	125
1-pipe steam system	100
Piped warm-air furnace	65
Pipeless furnace	35
Circulator heaters or stoves	15

For example, if a 2-pipe hot-water system for a 6-room house costs $500, the other types of heating systems for the same house ordinarily would cost about as follows: 2-pipe vapor system, $600, 1-pipe steam system $400; piped warm-air furnace $260; pipeless furnace $140; circulator heater or stove, $60. As already explained, these systems do not furnish equal degrees of comfort, and are not equally adapted to all types of houses.

HOT-WATER SUPPLY[7]

A supply of hot water for household use may be obtained from the heating system by use of a fire-pot heater or an indirect heater. Either type will provide reasonable quantities of hot water during the heating season at small cost.

OPERATION OF THE HEATING PLANT

The efficiency and operation of a heating plant can be improved by observing certain rules.

The manufacturers of furnaces and boilers generally supply printed operating instructions. If not received with the equipment they should be requested from the nearest agent or from the manufacturer,

[7] Farmers' Bulletin 1426, Farm Plumbing, contains detailed practical information on domestic water heating.

the size and serial number of the heater being given with the request. Some coal dealers distribute, free, excellent printed instructions for operating the furnace with the particular fuel furnished.

The ash pit should always be kept clean, as an accumulation of ashes under the grates may cause them to be burned or warped, with consequent waste of fuel and difficult operation. The flues should be cleaned regularly to insure proper draft and heating.

The following rules and information on equipment and fuels have been adapted from a folder prepared by the fuels division of the American Society of Mechanical Engineers. When this folder was issued the society estimated that from 10 to 20 per cent of the fuel usually required could be saved by observing these rules:

RULES FOR PREPARING EQUIPMENT

See that the grates are in good order.

Seal air leaks in ash pit and around clean-out doors.

Arrange coal bins so that two kinds of fuel can be kept separate.

KINDS OF FUEL

Stove and nut anthracite are ideal fuels for heating homes, but scarcity and cost restrict their use.

Gas coke burns excellently with anthracite pea or buckwheat, making a fire that will keep well and give heat when required.

Wood chunks, in combination with anthracite pea or buckwheat, make good fuel. They are equal to coke for producing heat, but require more attention. Wood chunks may be burned alone satisfactorily in furnaces with tight doors.

Bituminous coal can be used in most furnaces designed for hard coal, unless the flue passages are small and not easily cleaned. Bituminous coal demands more attention, and unless it is given will produce less heat. A heater of adequate size should be provided so that the fire need not be forced.

RULES FOR BURNING LARGE-SIZE ANTHRACITE

Carry a deep bed of fuel, at least level with fire doors.

Shake the grate to remove ashes and lower the fuel bed, but stop when the first live coals appear.

Fresh fuel should be spread evenly over the entire grate area. A heavy firing, 6 to 8 inches deep, can be made if desired and will last for six to eight hours. For quick kindling, the fire bed should be made fairly hot before fresh fuel is added.

After firing keep the dampers wide open until blue flame appears, then check the draft as much as necessary to keep the fire burning at the desired rate. The proper setting of the dampers for a given furnace must be learned by experience because of the variation in the draft available. In mild weather the fire may be checked effectively by allowing a bed of ashes to accumulate on—not under—the grate.

RULES FOR BURNING COKE WITH ANTHRACITE PEA OR BUCKWHEAT

Carry a deep bed of fuel even above the level of the fire door.

Shake the grate to remove ashes and lower the fuel bed, but stop when the first live coals appear.

Spread a thin layer of anthracite over the entire grate area and allow a few minutes for it to ignite. Next, fill the fire pot with coke, and allow this to burn until blue flame appears, then add another layer of anthracite.

After the charge is ignited, check the draft to the desired point.

When banking the fire for the night, use less coke and more anthracite, but otherwise fire in the manner described above.

Anthracite pea or buckwheat can often be used alone with success, if the draft is unusually good and the furnace amply large. Small-size anthracite ignites slowly. It is best to fire one-half of the grate at a time, allowing the first half of the charge to ignite before adding the second half. Small sizes of coal may be used in the fall and spring if not in the winter.

RULES FOR BURNING WOOD WITH ANTHRACITE PEA OR BUCKWHEAT

Follow the rules for coke and anthracite, substituting wood chunks for coke. It is highly important to see that the fuel is properly ignited and giving off flame before closing the drafts.

RULES FOR BURNING BITUMINOUS COAL

Bituminous or soft coal usually gives less heat than anthracite when fired in the ordinary residence heater, and therefore requires more attention.

A deep fuel bed is desirable and, as a rule, more draft is required.

Stir up the fire and get it hot before adding new fuel.

Before firing a new charge, push the partly burned fuel to the back or sides of the fire box, heaping it high on the sides of the fire-box walls. Place fresh fuel in the hole in the hot fuel bed, making it level with the heaped-up burning fuel. Never smother the fire by covering it completely with fine coal; always see that there is some flame showing.

After firing, check the draft to make the fire burn slowly, setting the dampers as found best by experience.

A large charge of soft coal will burn slowly for several hours, giving out moderate heat. If more heat is demanded it can be had by breaking up the partly ignited mass.

A little air should be admitted through the slides in the fire door.

TEMPERATURE REGULATORS

Temperature regulators for the ordinary coal-burning heating system are becoming increasingly popular. Such devices generally operate the dampers of the furnace according to the demand for heat in the house. The simplest type, however, merely opens the dampers at a certain time, and the dampers must later be closed by hand. Usually such controls may be obtained from local plumbers or from mail-order houses, at a cost of $5 to $10 including all necessary chain, pulley, etc. They can readily be installed by the house owner.

The more elaborate types of regulators maintain the desired night and day room temperature continuously. The simpler type of these controls obtains its motive power from a hand-wound spring, with two small electric dry cells for the thermostat circuit. In addition to saving labor, such devices may accomplish a substantial saving in fuel by preventing overheating. This type of temperature-control apparatus generally sells for $30 to $100, depending upon its completeness and quality.

WAYS OF CONSERVING HEAT[8]

If it is to be heated properly and economically a house must be tightly constructed. Heat is lost through walls, roof, and windows and through openings and cracks. Most farmhouses can be made more comfortable at small cost by applying insulation or by correcting construction defects.[9]

REDUCING WINDOW AND DOOR LEAKAGE

Storm or double sash provide an air space between the two layers of glass and also lessen infiltration of air, thus greatly reducing the

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[8] The author is indebted to T. A. H. Miller of the Division of Plans and Service, Bureau of Agricultural Engineering, for assistance in the preparation of this section.

[9] House Insulation, a bulletin prepared by the National Committee on Wood Utilization and issued by the U. S. Department of Commerce, describes the use of various insulating materials. For sale by the Superintendent of Documents, Washington, D. C., price 10 cents.

heat loss. Frost is much less likely to form on windows with storm sash. If hinged at the top and fitted with proper fastenings the storm sash may be swung open for ventilation. Storm doors have the same advantages as storm windows and also help to shut out drafts when persons enter or leave the house. Temporary vestibules at main entrances are very effective in preventing loss of heat.

Wood and felt weather stripping, properly installed, aids materially in keeping out cold air. It should be applied on the outside of the upper sash, and usually on the inside of the lower sash. The felt should be placed so close that more than ordinary effort is required to open the window, and so that the door must be pushed hard to lock. When first applied this stripping is highly efficient but may not remain so long. Many persons object to its appearance.

Strip felting may be used like wood and felt stripping, or forced into cracks. As a temporary expedient, strip felting may be used on the inside of all windows by tacking it around the frame so that it rests against the sash. It can also be used to close cracks under doors.

Metal weather-stripping is very efficient in reducing crack leakage around windows and aids in making a house weather-tight. It is obtainable in various forms. To install it the window sash must be removed and grooves cut to receive the metal strips. When the work is properly done most of the stripping is hidden, the exposed part has a neat appearance, and windows slide easily. Metal weather-stripping for outside doors is also helpful.

Tight thresholds under bedroom doors prevent cold drafts into other rooms when windows are open.

REDUCING HEAT LOSSES THROUGH WALLS AND ROOFS

Much heat is often lost through the roof, as can be seen on a frosty morning, when frost clings to the overhanging gables and eaves but quickly melts from that portion of the roof through which heat is escaping.

When the ceiling joists are covered only with lath and plaster on the lower side, heat readily escapes from the rooms below. There are several remedies such as flexible insulating material between the joists; board insulation nailed on top and later covered by flooring if needed; or a layer of noncombustible granular material over the plaster and between the joists. When the ceiling joists are covered on both top and bottom, all openings between joists at the eaves should be blocked to shut out cold drafts. (Fig. 7, C.) Where the attic is to be heated, the insulation should be nailed to the underside of the roof rafters and on the end walls to serve also as a wall finish.

Sometimes there are large cracks at the eaves because sheathing and siding were not extended between the rafters. They can be closed by nailing blocks between the rafters or by being sealed with plastic materials.

Wall openings for windows and doors often admit cold drafts. A house is sheathed before the window and door frames are set, consequently the sheathing is not fitted snugly against the frame, and only the trim obstructs the entrance of cold air. To remedy this, the outside trim may be removed and a piece of heavy felt or

painted metal used to seal the openings. The joints will be tighter if the back of the trim is given a heavy coat of paint before being nailed in place.

Frames in masonry walls become loose and the resulting opening between frame and masonry should be calked by forcing oakum, coated with plastic roofer's cement, into the cracks with a putty knife or a broad-faced calking iron; mortar commonly used for this purpose will not provide a permanently tight joint. Small cracks can be stopped with putty if they are carefully filled.

Siding which has become loosened by shrinking, warping, or action of the weather, should be tightened with rust-resistant nails. A good coat of paint and the liberal use of putty will seal many small cracks after the siding is tightened. A very effective and practical method of insulating frame houses on which the siding is defective or poorly installed, is to shingle the outside of the walls, using a heavy building felt between the shingles and the siding.

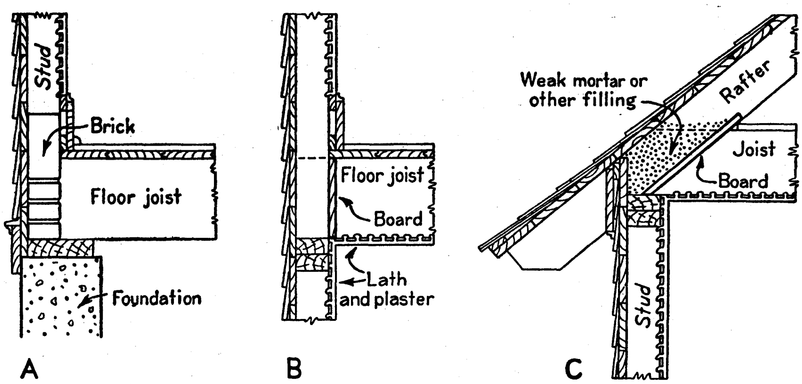

FIGURE 7.—Method of stopping drafts in walls: A, at first floor; B, at second floor; C, at attic floor

The studding of the exterior walls often form flues extending from the foundation to the upper stories. Such construction permits heat in the cellar to rise to the attic and escape through cracks at the eaves or in the roof, or cold air from outside to circulate in the walls, chilling them or passing into the rooms. Cold walls cause moisture to condense, spoiling the wall finish and creating other nuisances. Figure 7 illustrates how blocking may be used in the walls to prevent the flow of air through these flues. In new construction the spaces at the ends of second-floor joists should be blocked.[10] The blocking at first and attic floors may be placed in old houses.

Condensation of moisture on the inner surfaces of thin masonry walls can be prevented by the use of lath and plaster or wall board, separated from the masonry by wooden or metal furring strips. The air space provided by such construction results in a warm dry wall.

Single floors are likely to be cold if the building is supported on piers or if the cellar is not heated. Double floors with paper between the subflooring and the finished floor are very desirable. When

[10] Farmers' Bulletin 1590, Fire-Protective Construction on the Farm, illustrates methods of blocking fire channels. Fire stops are also effective in reducing air currents.

houses are supported on piers, boards are often placed to the height of the first floor and banked in winter with earth or forage. It is, of course, better to build a full inclosing wall.

Much heat may be lost through an open fireplace. A damper should be provided to close off the chimney in cold weather if there is no fire on the hearth. At other times the fireplace may be utilized to provide ventilation.

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